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ABSTRACT

This paper reports the results of a study designed to examine how students with different learning styles functioned in World Wide Web-based courses offered by Project BIO at Iowa State University in the Fall of 1997, and to determine what factors influenced their learning. The objectives of the study were to identify: (1) the demographic characteristics of the students by learning styles; (2) how students' learning strategies, patterns of learning, and achievement differed in relation to their learning styles; and (3) relationships among student learning styles, learning strategies, patterns of learning, achievement, and selected variables. The population for this study was 99 students taking two non-major introductory courses. These two Web-based courses were stand-alone courses in which most course materials and resources were accessed and delivered by the Internet. An online questionnaire that included a learning strategies scale, a patterns of learning scale, and demographic questions was designed and posted on the Web. A total of 78 students also took the Group Embedded Figures Test (GEFT), a learning styles test. Total data were collected on 74 students. Results indicated that learning styles, patterns of learning toward Web-based instruction, and student characteristics did not have an effect on Web-based learning achievement. (DLS)

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Learning Strategies and Other Factors Influencing Achievement via Web Courses

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Introduction

As the popularity of the World Wide Web (WWW) increases, its use as a means of delivering instruction is also growing. The World Lecture Hall lists almost 700 courses that are delivered by higher educational institutions via the Web, and this list is growing daily (Parson, 1998; World Lecture Hall, 1998). Alexander (1995) believed that "the greatest potential of the Web, however, lies in the fact that we have a chance to learn from the lessons of the previous faded technologies, and an opportunity to develop new learning experiences for students that have not been possible before" (p. 3). However, Parson (1998) and Alexander (1995) argued that while implementing a new technology, educators should evaluate how students learn via the new technology so as to help with curriculum and instructional designs. Parson (1998) added that it is important to understand how the new technology can affect learning when it is used by different types of learners.

Identifying students' learning styles helps educators understand how people perceive and process information in different ways. Garger and Guild (1984) described learning styles as "stable and pervasive characteristics of an individual, expressed through the interaction of one's behavior and personality as one approaches a learning task" (p. 11). Literature (Witkin, Moore, Goodenough, & Cox, 1977; Raven, Cano, Garton, & Shellhamer, 1993; Miller, 1997a; Miller & Honeyman, 1997) on learning styles suggests that field-dependent learners tend to approach a problem in a more global way, are socially oriented, prefer collaboration, and are extrinsically motivated. In contrast, field-independent learners tend to approach a problem more analytically, rely on self-structured situations, prefer competition, and are intrinsically motivated.

Like the literature on learning styles, the literature on learning strategies explores different ways of learning. However, in assuming stability as well as lack of individual control, learning style literature suggests that it may be difficult for students to change their learning styles, whereas learning strategy literature assumes that students' use of learning strategies can be controlled by learners and changed through teaching (Pintrich & Johnson, 1990). According to Cross and Steadman (1996), cognitive learning strategies are methods learners can use to improve their understanding, integration, and retention of new information. Learning strategies include a wide variety of cognitive processes and behavioral skills (Weinstein & Keyer, 1991). General learning strategy components include rehearsal, elaboration, organization, comprehension, metacognition, and resource management (Weinstein & Keyer, 1991; Cross & Steadman, 1996).

Miller (1997b) identified twelve learning strategies used by the students studying agriculture through videotapes. Pausing the tape while viewing and taking notes was the most used learning strategy by the students taking videotape courses. Miller defined learning strategies as "the techniques or skills used by an individual in accomplishing a learning task" (Miller, 1997b; p. 21). His definition is different and not as broad as the definition in Mayer's study (1988). Mayer defined learning strategies as "behaviors of a learner that are intended to manipulate a person's cognitive processes during learning" (Mayer, 1988; p. 11).

In their study on relationships between learning strategies and learning styles in a hypermedia environment, Liu and Reed (1994) used the term "patterns of learning" in discussing learning strategies. In Lui and Reed's study, patterns of learning were measured by identifying how often the students accessed different functions in a hypermedia environment and how long students used the courseware, which seems to be quite similar to Miller's (1997b) definition of learning strategies. Liu and Reed (1994) found that different learning style groups employed different patterns of learning in completing the same task.

What do we know about the way students learn through the new technology, the WWW? What are the important learning factors in Web-based courses? Do student learning styles, learning strategies, and patterns of learning influence learning achievement? Research is needed to obtain more understanding of the learning factors that influence students' success in Web-based learning. Moreover, research is needed to understand student learning strategies and patterns of learning with different learning styles via WWW. This type of research will assist educators in planning, organizing, and delivering quality Web-based instruction in a manner that will improve student learning.

Purpose and Objectives

The purpose of this study was to examine how students with different learning styles functioned in Web-based courses that were offered by Project BIO at Iowa State University, and to determine what factors influenced their learning. The objectives of the study were to identify: (a) the demographic characteristics of the students by learning styles, (b) how students' learning strategies, patterns of learning, and achievement differed in relation to their learning styles, and (c) relationships among student learning styles, learning strategies, patterns of learning, achievement, and selected variables.

Methods and Procedures

The population for this study included 99 students taking the two non-major introductory courses, Zoology 155 and Biology 109, offered by Project BIO at Iowa State University in the Fall of 1997. Theses two Web-based courses developed through Project BIO were stand-alone courses in which most course materials and resources were accessed and delivered by the Internet.

An on-line questionnaire was designed by the researchers and included two scales plus demographic questions. The questionnaire, written in HTML format, was posted on the web. Thirteen statements representing the learning strategies scale were selected from a learning strategy instrument, Motivation Strategies for Learning Questionnaire (MSQL) developed by Pintrich, Smith, Garcia, and McKeachie (1991). The students were asked to rate themselves according to how well the statements described them while they were

taking the Web-based course by using a five-point Likert-type scale. The scale had response options from (1) Not at all typical of me, (2) Not very typical of me, (3) somewhat typical of me, (4) Quite typical of me, to (5) Very much typical of me. Fifteen statements representing the patterns of learning scale were developed by the researchers based on the techniques or interactive functions in the Web-based courses that students used to accomplish a task. The five-point Likert-type scale had response options ranging from (1) None of the time, (2) Part of the time, (3) Some of the time, (4) Most of the time, to (5) All of the time. Demographic variables included courses previously taken in the subject area, study and work hours per week, class level, and gender.

Content and face validity for the questionnaire were established by a panel of three faculty members associated with Project BIO and three graduate students in Agricultural Education. The Likert-type scales were pilot-tested for reliability with 38 students taking a different undergraduate Project BIO Web-based course, Biology 201. Cronbach's alpha coefficients were .80 and .73 for the learning strategies, and patterns of learning scales, respectively. The researchers administered the learning style test (GEFT) to on-campus students and the off-campus students were administered the GEFT by their proctors. The reliability coefficient for the GEFT was .82 (Witkin, Oltman, Raskin, & Karp, 1971).

A total of 78 (79%) students completed the GEFT. An on-line questionnaire was posted on the web three weeks before the final exams. A follow-up electronic letter to nonrespondents of the on-line questionnaire yielded a total of 94 responses for a 95% return rate. Nonresponse error was controlled using responses from those students who completed the GEFT after the deadline for taking the learning style test. For purposes of analysis, the learning style (GEFT) scores, questionnaire responses, and students' grades, which were provided by the instructors at the end of the semester, were matched. Respondent and nonrespondent data were pooled yielding a total number of 74 (75%) responses.

Data were analyzed using the Statistical Package for Social Science, Personal Computer Version (SPSSx/PC). Analyses of data included frequencies, means, standard deviations, t-tests, Pearson and point biserial correlations, and regressions. The alpha level was established *a priori* at the .05 level.

Results

The usable responses included 29 (39%) in the Zoology class and 45 (61%) in the Biology class. Less than half (29; 39%) of the usable respondents were males. Twenty-eight (38%) were high school students and forty-six (62%) were university students. More than two thirds (51; 69%) of the respondents were field-independent learners. On average, the students had previously taken 1.45 courses in the subject area of Zoology or Biology. The students spent an average of 3.27 hours per week studying, ranging from 1 to 20 hours and worked an average of 16.97 hours per week, ranging from 0 to 80 hours. No significant differences by learning styles were found in the number of courses taken previously, study hours per week, or work hours per week.

Field-dependent students (mean = 3.27) had almost the same mean on the learning strategy scale as did field-independent students (mean = 3.25), and no significant difference was found in the t-test when comparing their use of learning strategies. Moreover, four mean scores of the thirteen learning strategy items were rated above 3.50. The highest-used

learning strategy was to find the most important ideas from lectures (mean = 3.85). The second most highly used strategy was to memorize key words of important concepts (mean = 3.76). The third most highly used strategy was to relate the material to what they already know (mean = 3.70). The next most highly used strategy was to determine the concepts they did not understand well (mean = 3.68). The two lowest used strategies had mean scores under 2.50. They were "to give up the difficult parts and study the easy" (mean = 2.16) and "make charts or tables to organize the material" (mean = 2.14). The overall mean score for students' use of learning strategies was 3.25 with a standard deviation of .51.

Although field-dependent students (mean = 3.00) indicated that they spent more time based on their patterns of learning in Web-based courses than field-independent students (mean = 2.83), no significant difference was found. Six patterns of learning were rated above the mean score of 3.50. They were: check scores of the tests or assignments (mean = 4.54), view the slides (mean = 4.19), listen to the audio of the lessons (mean = 3.95), check the answers of the tests or assignments (mean = 3.93), read course handout package (3.70), and take notes while listening to the audio of the lessons (mean = 3.58). Five patterns of learning were rated below the mean score of 2.00. They were: listen to the audio more than once (mean = 1.84), communicate with the class via e-mail (mean = 1.82), communicate with the class via discussion net forum (mean = 1.80), use the CD ROM disk accompanying the textbook (mean = 1.47), and communicate with the class via chat net forum (mean = 1.47). The overall mean for how often students used the patterns of learning in Web-based courses was 2.88 with a standard deviation of .53.

Although field-independent students' standardized achievement (mean of z-score = .06) was higher than field-dependent students' (mean of z-score = .14), the results of the t-tests showed that no significant differences were found on the respondents' overall achievement scores by learning styles.

Pearson correlations and point biserial correlations were used to describe associations between student standardized achievement score and selected variables. Nine relationships were examined that ranged in magnitude from substantial to none. The relationship between the two variables, student achievement and learning strategies, (r = .50) was significant. No significant relationships were found between student achievement, gender, Web-based courses they were taking, whether or not they were university students, previous experience in the subject areas, hours per week studying and working, and learning style scores.

A hierarchical regression analysis was conducted to ascertain the amount of variance in students' standardized achievement scores by the variable of interest. The regression model was loaded first with the learning strategies variable, which explained 25% of the variance in achievement. The patterns of learning variable was entered next into the regression. This variable did not explain any additional variance in student achievement. Then the learning style variable was entered into the regression model, and it explained an additional 2% of the variance in student achievement. Learning strategies was the only significant variable for the explanation of variance in achievement scores.

Conclusions/Recommendations

Student learning styles, patterns of learning toward Web-based instruction, and student characteristics (whether or not they were university students, gender, previous experience in the same subject area, study and work hours/week) did not have an effect on their Web-Based learning achievement. Moreover, field-independent students did not differ from field-dependent students in their learning strategies and patterns of learning in Web-based courses. The conclusion was that different types of students using different learning strategies and patterns of learning with different learning styles can learn equally well in Web-based courses.

Students were slightly positive about the use of learning strategies and were around midpoint in their frequency of use of learning patterns in Web-based courses. Trying to find the most important ideas from lectures and memorizing key words of important concepts were the two highest-used learning strategies; checking scores of tests or assignments and viewing the slides were the two highest-rated patterns of learning. Students used least the learning strategies of making charts or tables to organize the material. They used least the patterns of learning of communicating with the class via e-mail, discussion net forum, and chat net forum. It was concluded that students used more rehearsal and elaboration learning strategy and less organizational learning strategy. And they used more patterns of learning in studying the course information and checking their grades than in communicating with the class. The researchers recommended that educators should provide students with learning opportunities by using a variety of learning strategies to assure students' understanding, integration, and retention of course concepts. Additionally, educators should encourage students to use more of the communicating techniques or functions, such as e-mail, discussion and chat forums, for more interactive learning in Web-based courses.

Learning strategies seem to be the most important factor in Web-based learning and accounted for one fourth of student achievement. Use of learning strategies by the students correlated significantly with student achievement. The higher the student scored on a general use of learning strategies, the higher the student's overall achievement in the class. This was supported by Pintrich and Johnson (1990), and Weinstein and Underwood (1985). They indicated that students use more learning strategies usually learn more than students who use few of the strategies. Additionally, they also believed that learning strategies can be controlled by learners and improved through instruction. It was recommended that educators should assist students in understanding and mastering different learning strategies to help them becomes better learners.

Further study is needed to identify learning strategies and patterns of learning between high achieving and low achieving students in Web-based courses. Are the most highly used learning strategies used by the highest achieving students? Are communication functions used by the high achieving students? These are questions that need to be answered as Web-based instruction becomes more and more common.

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